

GENERAL CONCLUSION (ECOSYSTEMATIC PHILOSOPHY)

Geotectonic changes of the Earth's crust during the past geological epochs resulted in establishing of natural bridges, new straits, periodical desiccation of the shelf which promoted to the natural migrations of organisms and evolution of marine and terrestrial ecosystems (**Fig. 74**).

Development of civilization, especially during the past 100 years, contributed considerably to the evolution of the ecosystems (**Fig. 75**). The combination of construction of canals, dams, large scale shipping, settling of exotic species, growth of the artificial mortality of many marine mammals and fish species, chemical contamination by the beginning of the 21st century led to the situation, when ecosystems acquire the features favorable for domination of new fish species with little commercial value and the aboriginal fishes lose the competition.

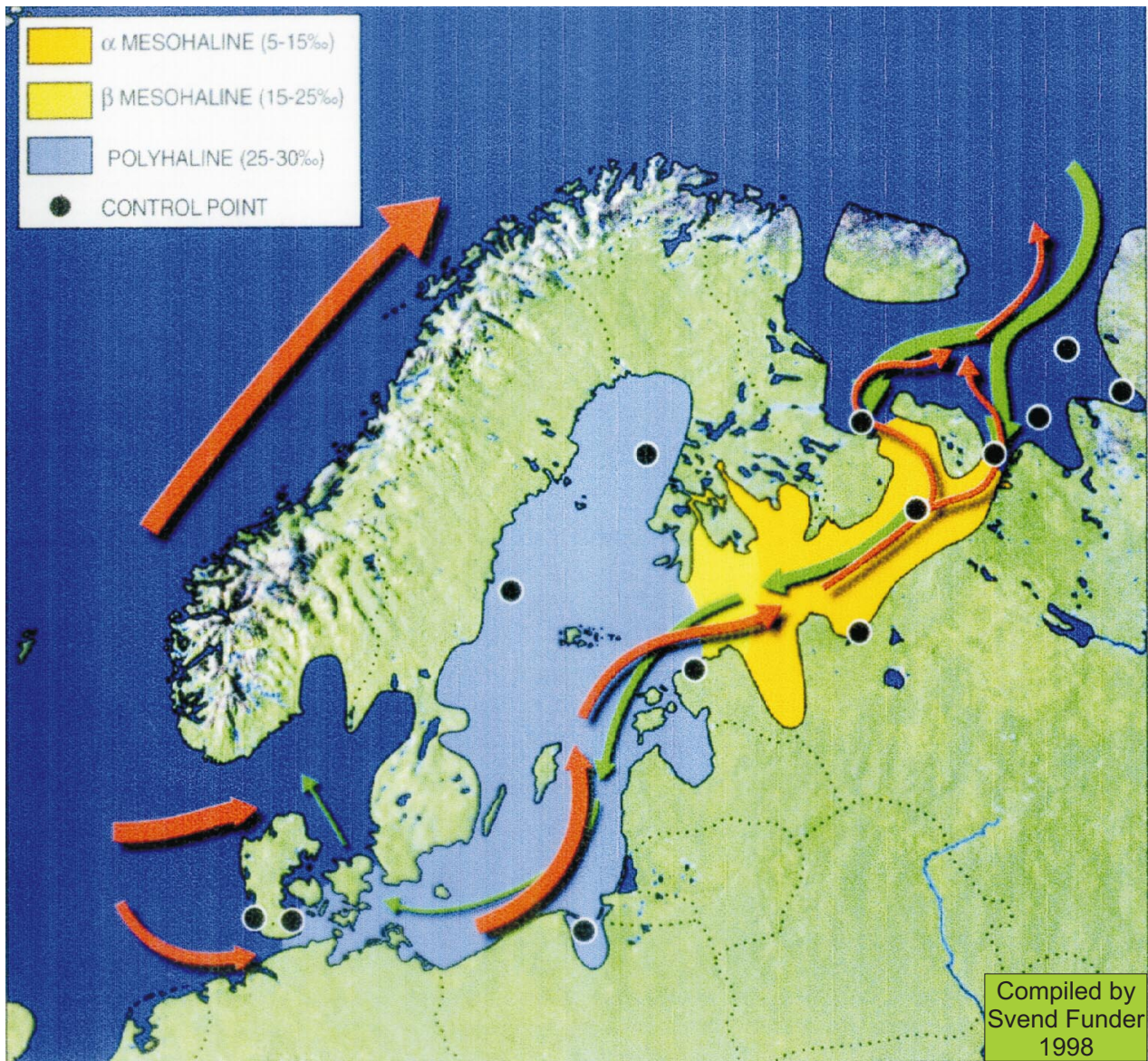


Fig. 74. Example of marine biota settling via land (by Sv. Funder 1998)

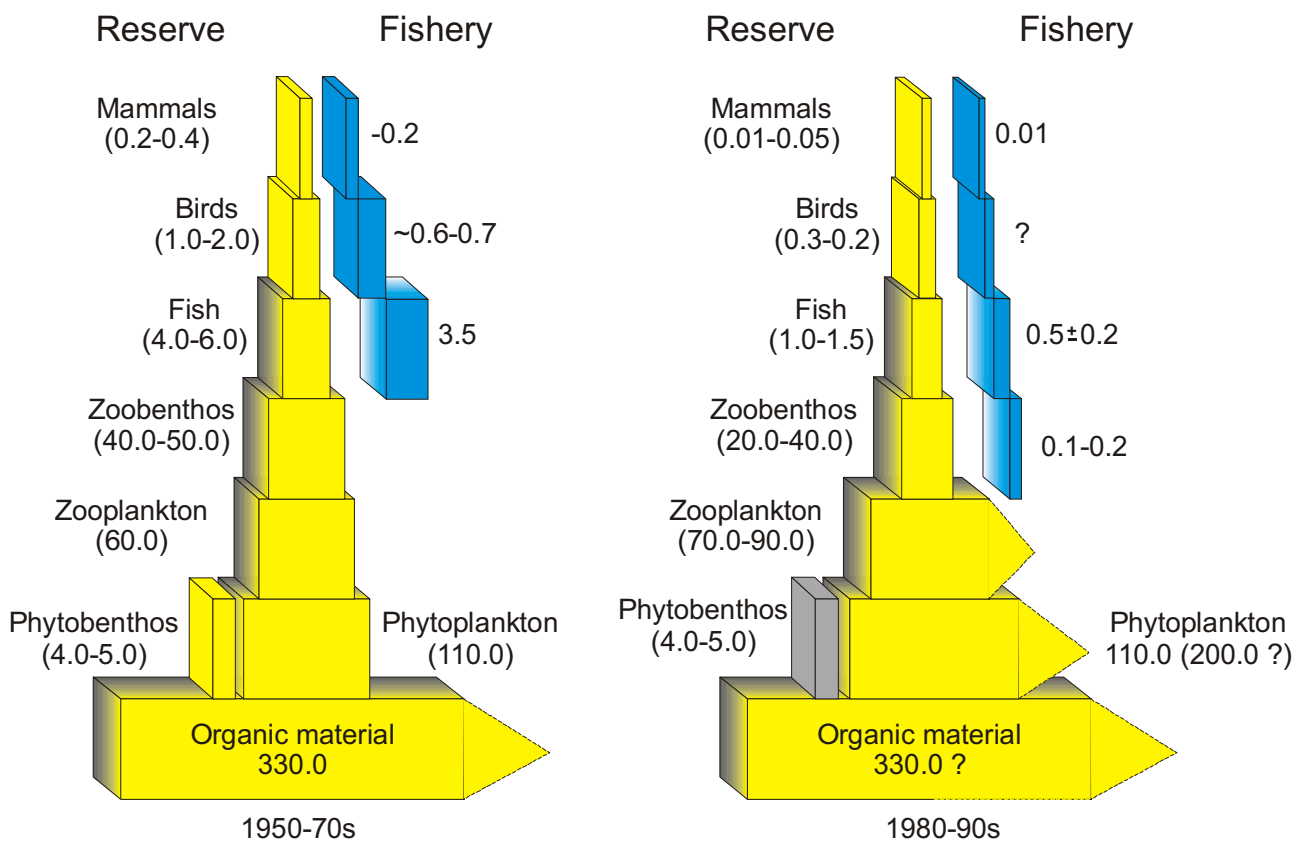


Fig. 75. Pattern of the Barents Sea ecosystem pyramid changes in the 1950-90s (annual production and the fishery stress, million t)

Marine ecosystems preservation is impossible without the agreed position of all the institutions. The fate of the sturgeons in the Azov Sea may serve as a glaring example of the non-coordinated actions of all the ministries and absence of the uniform state policy. In the late 1950s and early 1960s several development programs incompatible with preservation of ecological balance overlapped.

Firstly, the Tsymlyansk hydro power plant construction was finished which cut off the major part of the sturgeon spawning grounds. Secondly, the hydrochemical regime and the contamination level in the waters of the Azov Sea changed because of the river run-off decrease and fulfillment of the program of agricultural use of chemicals. Thirdly, at the same time the intensive extraction of the Azov Sea gobies (in 1957 up to 92,000) with the trawls which practically plowed the ground together with the bottom fauna. As the result, the forage base of the sturgeons was destroyed. It is known, that the main food item of the white sturgeon and the starred sturgeon are the gobies and that of the sturgeon are worms and benthic mollusks. All these upset the natural population of the sturgeon and since the 1980s it is maintained by artificial rearing.

Luckily a large project of construction a dam across Strait of Kerch at the beginning of the 1970s has not been realized. The idea to build a hydro complex was the reaction to inflow of the Black Sea salt water to the Azov Sea in conditions of the fresh water run-off deficit. The consequences might have been similar to the Gulf of Finland situation, which is barred with a dam. Artificial reduction of water exchange with the Baltic Sea increased the accumulation of pollutants, eutrophication and other stagnation phenomena.

The examples of such an attitude towards highly productive water reservoirs are many. The fate of the Aral Sea is the most dramatic.

As far as ecological problems connected with the introduction of the exotic fauna into the European seas (including intentional introduction) are concerned the following should be noted. The total ecosystematic consequences of the given process are negative, mainly due to the mixing of the natural faunas, populations and genetic funds, loss of the natural zoogeographical identity, ousting of the aboriginal ichthyofauna. That is why either habitual for many decades practice of “nature improvement” by introduction or steady restoration of aboriginal fauna should be recognized as a long-term priority.

We adhere to creating conditions for restoration of aboriginal valuable fish species. Any outside intrusion into marine ecosystems, introduction included, must be preceded by biological evaluation and state assessment. The role of studies of institutes of Russian Academy of Sciences in dealing with this problem should become more prominent.

One of the main conclusions of this work is that contemporary changes in populations structure, species composition and general misbalance of the biological processes in marine ecosystems resulted from a combination of numerous direct and indirect factors (**Fig. 76–78**).

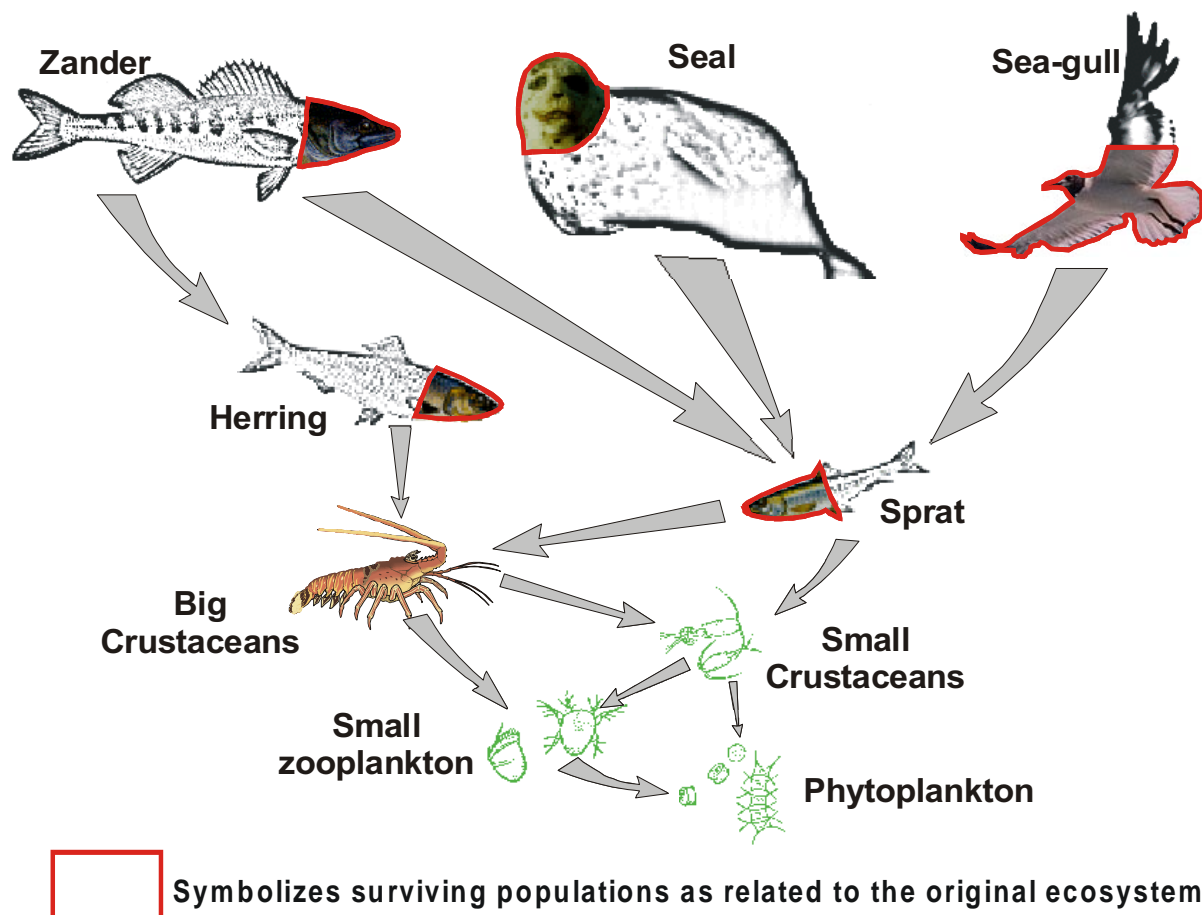
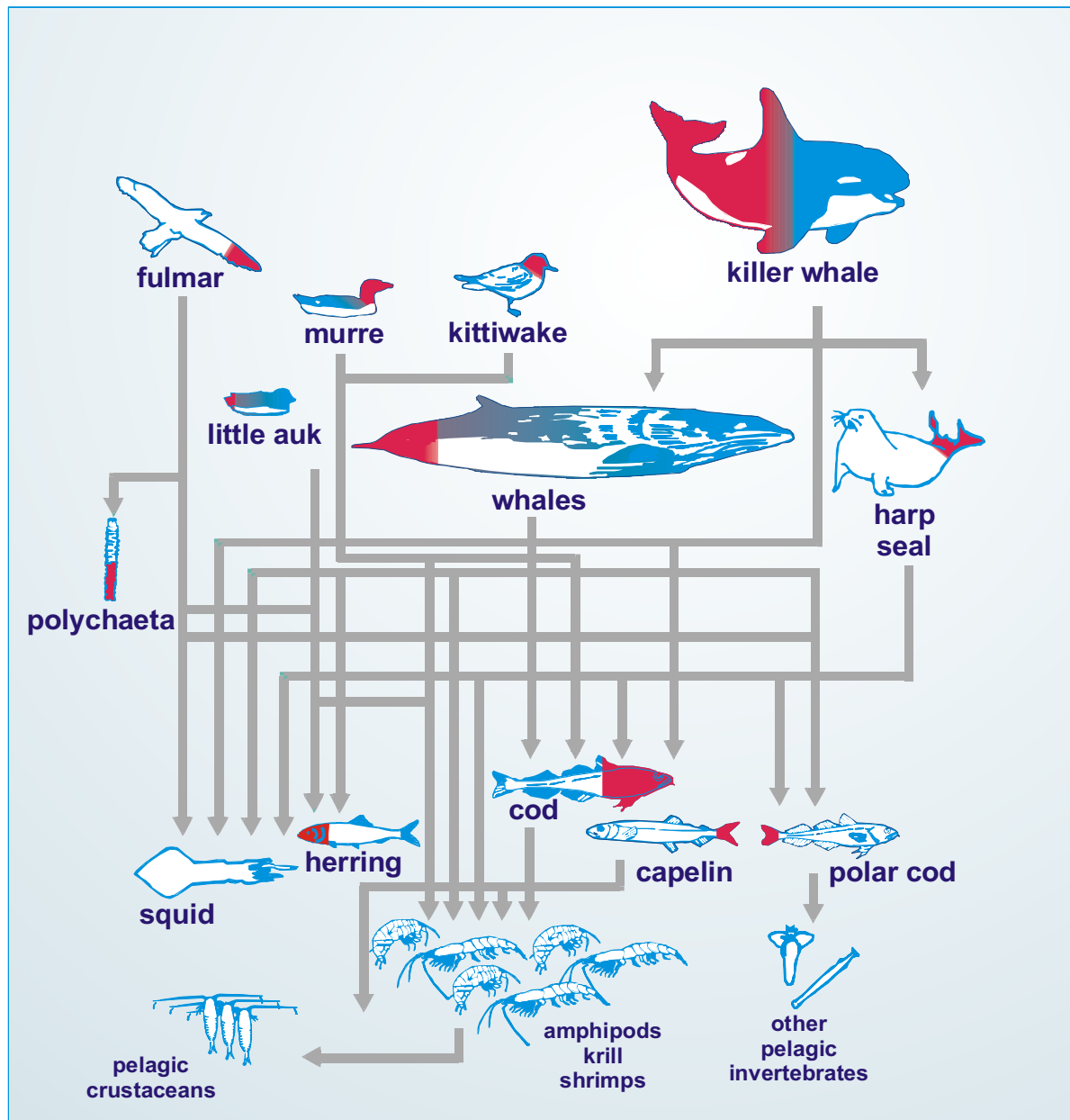


Fig. 76. Current pattern of the food chain in the ecosystem of the pelagic waters of the Caspian Sea (the pattern principles by Zenkevich 1963)




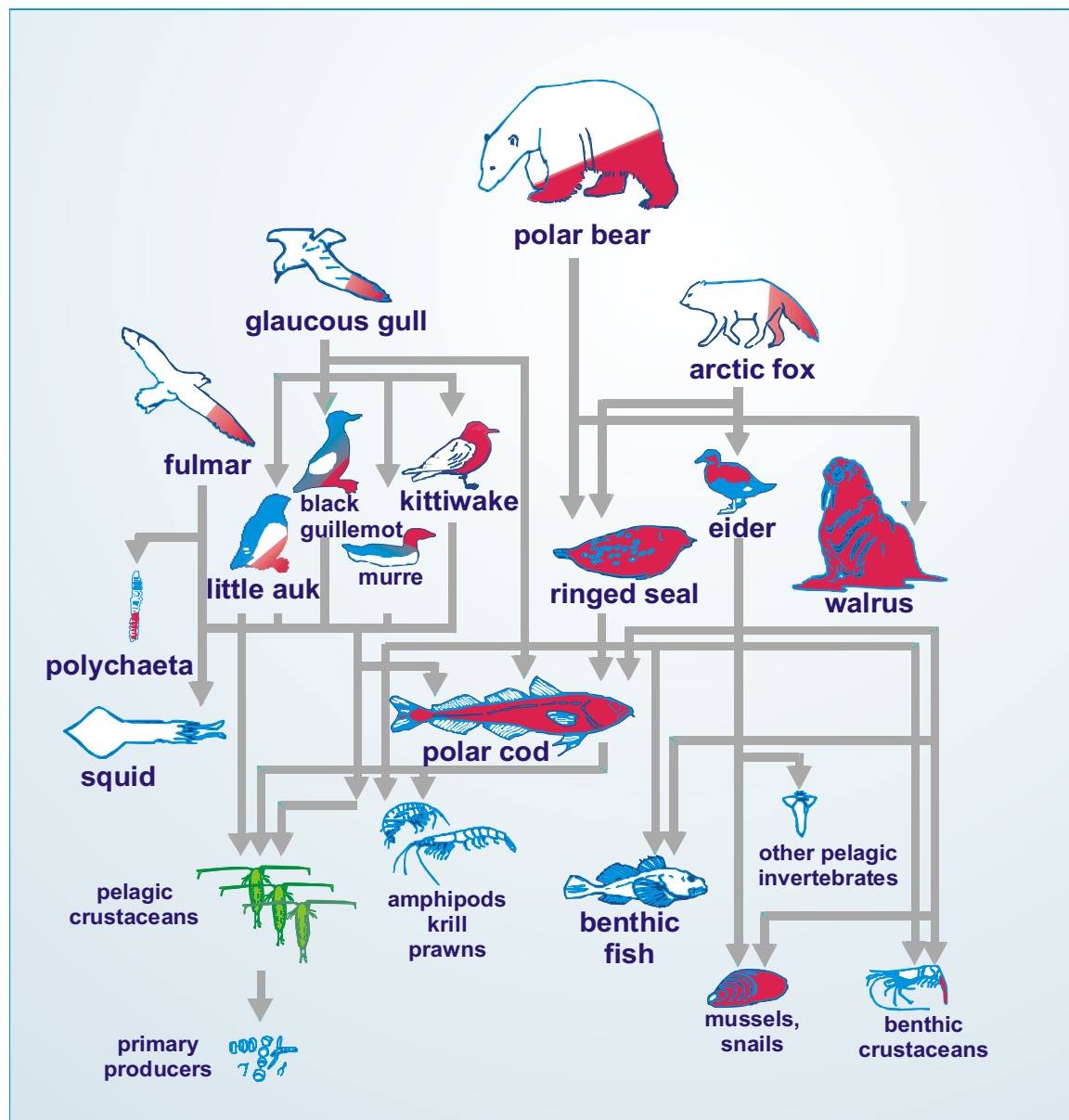

 Symbolizes survived populations as related to the original ecosystem

Fig. 77. Disrupted system of natural interrelations in the Barents Sea ecosystem (Atlantic waters) (the pattern principles by The State of the European Arctic 1996)

Mass cannibalism, lowering of the growth rate, fecundity, fatness, eggs size clearly indicate the tendency of decreasing level of natural restoration of practically all main commercial fish species. On the whole, fall of reservoirs' fish productivity predetermined a sharp decrease of abundance of sea animals feeding on fish. Overexploitation caused the reduction of original abundance of commercial fauna from walruses and whales to mollusks.



 Symbolizes survived populations as related to the original ecosystem

 Symbolizes increased abundance of species related to the ecosystem transformation

Fig. 78. Disrupted system of natural interrelations in the Barents Sea ecosystem (Arctic waters) (the pattern principles by The State of the European Arctic)

The given analysis allows us to come to the conclusion, that in both the northern and the southern seas the overcatch of the mass pelagic fish species – herring, polar cod, capelin, Black Sea sprat (common kilka) and European anchovy turned out to be the main reason of upsetting of the energy balance and the ecological pyramid. These small shoal fishes are known as the key elements in the marine ecosystem food chains. In fact, almost unbridgeable gap has appeared in marine ecosystems between its inferior (plankton, benthos, algae) and top elements (predator fishes, birds, mammals).

According to the estimations of *PINRO* and *VNIRO* specialists, the total catch of Russian fisheries in the European seas of Russia at the turn of the 21st century will comprise 400,000–600,000 t depending on the mode of exploitation. The Barents Sea share in the amount and diversity of bioresources will remain the biggest.

We cannot but mention the further development of the Barents Sea ecosystem crisis which started in the 1980s. During the last two decades, the population of such Barents Sea species as halibut, wolffish, ocean perch, plaice has not reached ecologically safe indices. The consequences of collapse of populations of such key pelagic fishes as herring and capelin will be surely observed in the next century. Attempts to resume catching of herring and capelin during temporary outbursts of abundance can only aggravate the Barents Sea ecosystem unbalance.

The said bioresources procurement could be economically justified in the 1950–80s when both mariculture and the market were undeveloped. At the same time, long term consequences on the ecosystem level were not as clear as at the turn of the 21st century. Restoration of marine ecosystems calls for setting up limitations on procurement of Arctic cod, common kilka, capelin and other small fishes. This would be good for the state as it will give a chance not to waste valuable commercial fish species completely.

Further use of marine bioresources requires switching from maximum allowable catch assessments of several principal commercial fish species and marine mammals to the principles of ecosystem management.

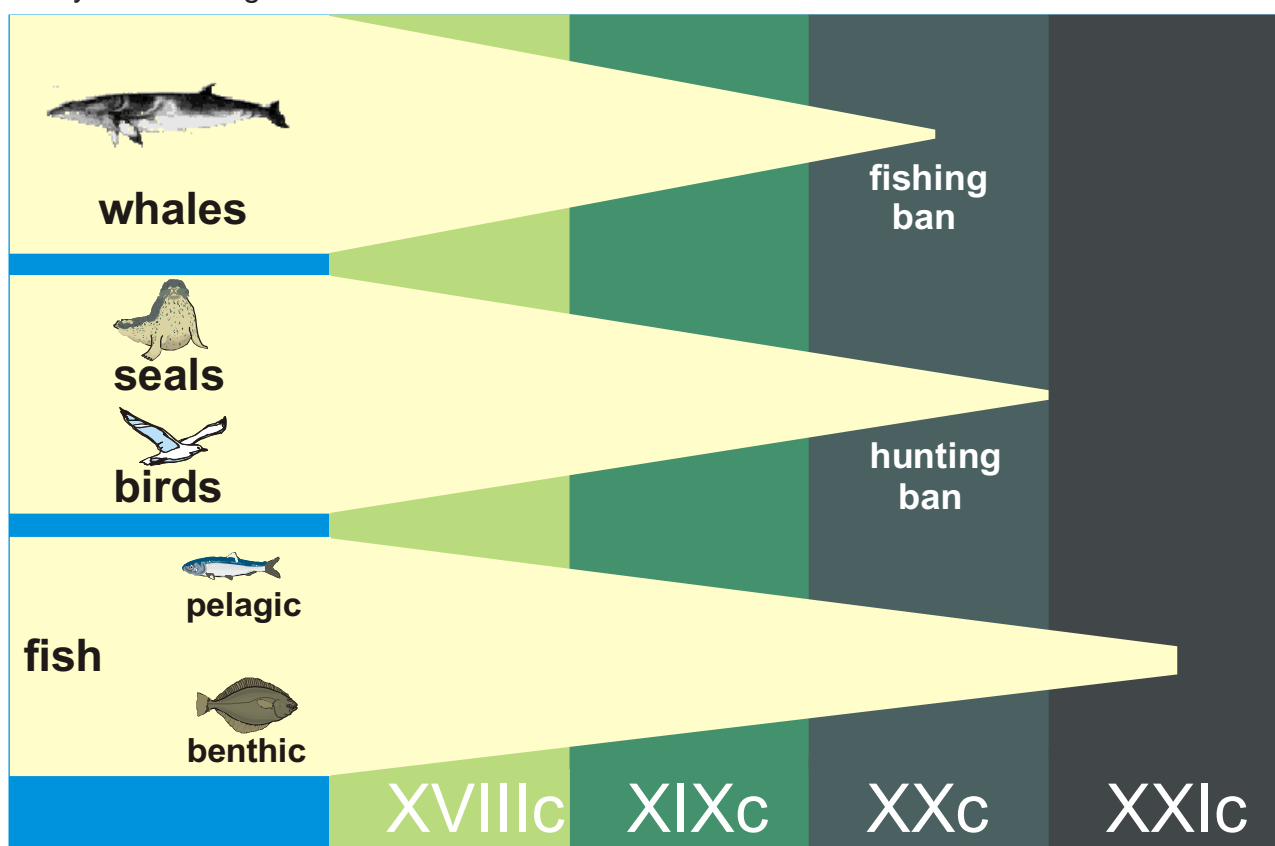


Fig. 79. Dynamics of decrease in commercial fish species abundance in the European seas of Russia

Restoration of the abundance of the mass small-size fish species will provide the conditions for preserving of sea avifauna and especially of such groups of birds as the guillemots (the Alciformes). In the current situation principally new approach to creation of the modern concept of exploitation of water animals is needed. It should be based on really new notions of the role of sea birds and marine mammals taking into consideration their multiple interrelations with the other elements of marine ecosystems. Otherwise the traditional ways of sea birds and marine mammals protection (establishing of nature reserves and protected areas) become pointless.

The modern approach is that chemical contamination is the dominating factor that influences the biosphere. This is true for the terrestrial ecosystems but not for the marine ones. The polluted Azov Sea and practically clean Barents Sea might serve as an illustration. Despite big difference in the levels of contamination, the decrease of commercial species abundance is practically the same (5–10 times). This fact can hardly be disputed. In our opinion, determination of a single contamination factor is not sufficient for explaining of the ongoing changes.

Marine ecosystems susceptibility to the anthropogenic and natural pressure depends on the basin's dimensions, intensity of the exchange processes with the World Ocean, degree of seawater freshening or salinization, scale of the water reservoirs productivity and other factors. Development of quantitative criteria and thresholds of the marine ecosystems stability needs special investigations so that to prevent continuous decrease of bioresources abundance in the European seas of Russia (**Fig. 79**).

Thus, if the above mentioned seas be positioned on a virtual scale of anthropogenic transformations, then the ecosystems of the Barents and the White Seas will take position in the least affected sector. The Baltic, Black and Caspian seas biota are affected to a greater extent. The situation in the Azov Sea, like that in the Aral Sea, which reflects all the negative aspects of human activity, may be defined as an ecological catastrophe of the end of the 20th century.

Solving this national level problem calls for placing it among the highest priorities of fundamental scientific research and the programs of the economic development of the country.

Everything mentioned above is only a part of the problems which, in our opinion, deserve special attention of the academic and applied science, legislative and executive bodies.